The Components of Calibration:

- Offset
- Gain
- VFDG timing

Offset: Take data with no signal.
Gain: Take data with centered "beam" signal.
VFDG Timing: Sweep VFDG timing over centered signal, choose VFDG values that maximize amplitude.

Each of these 3 calibration items needs to be done 4 times per board; x1 gain, x10 gain, positive polarity, negative polarity.

Internal Calibration

The internal pulser can be used to calibrate the electronics in the field.

Problem:

The resistors on the front-end splitter board have a tolerance of 1%. This adds a large enough uncertainty so that calibrations done with the internal pulser are unusable.

Assumption:

The error introduced by the resistors will not change over time and/or temperature.

Solution:

Make an internal calibration and an external calibration consecutively, storing the data from each to create a characterization of the error of the front-end splitter board. Future internal calibrations can then correct this error.

The Calibration Method:

To calibrate-out the error in the front-end splitter board, a baseline calibration is required for both the internal and external signal paths.

Once the baseline calibrations have been taken, an internal calibration can be done at any time to recalibrate the board.

This internal re-cal uses the information already obtained to correct the error introduced by the front-end splitter board.

Types of Calibrations:

- External Baseline
- Internal Baseline
- Internal Recent

External Baseline:
Requires signal from an external pulser. Not practical to be done in the field during operations. Only done once, at the same time as the internal baseline.

Internal Baseline:
Uses the internal pulser. Only done once, at the same time as the external baseline.

Internal Recent:
This is the re-cal done at any time after the baseline calibrations have been taken. The program applies corrections to this measurement and creates new calibration coefficients.

How the program handles the multiple calibrations:

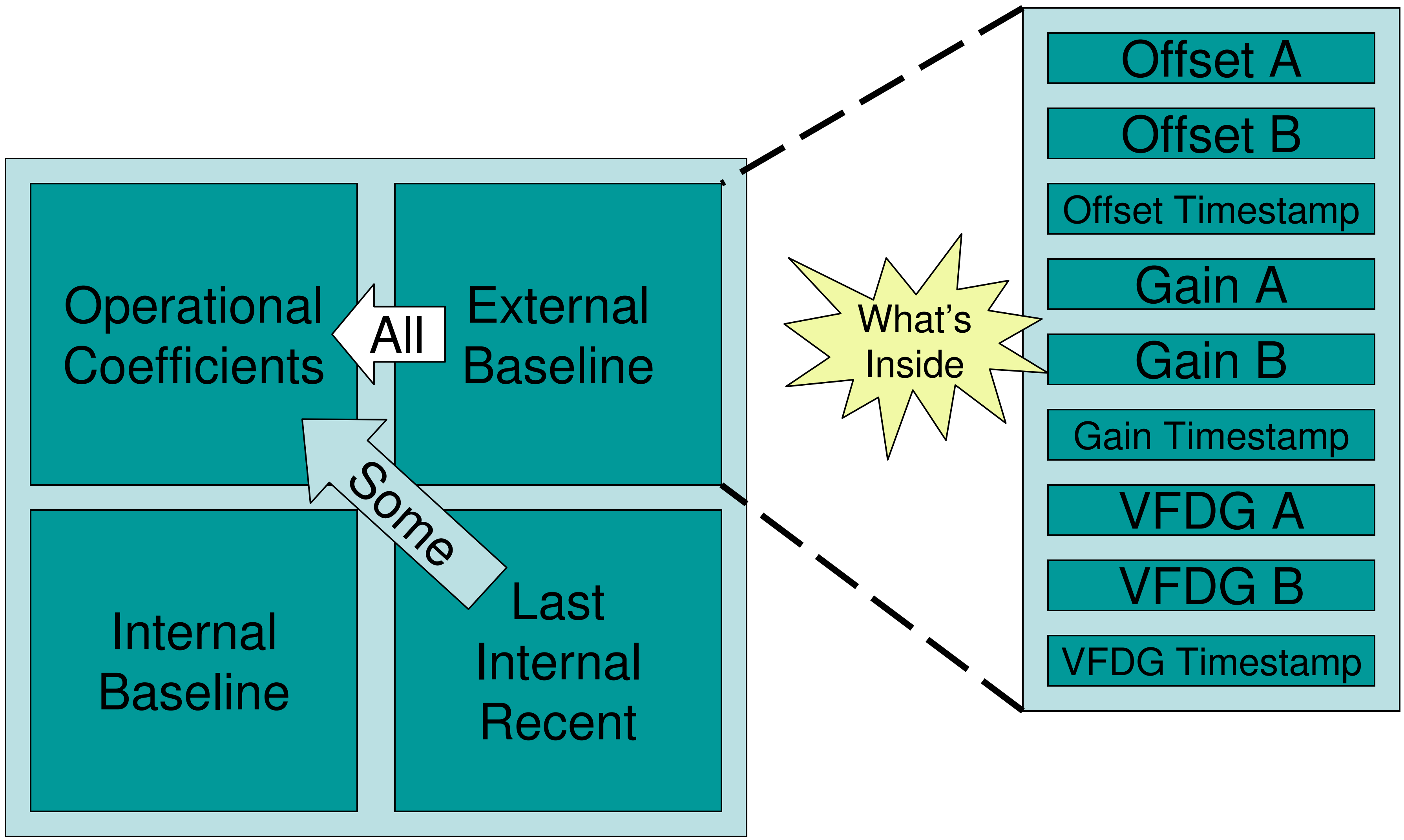
Each type of calibration has it's own coefficient block in non-volatile flash memory. Each block has the same form.

In addition to the coefficient blocks for the three types of calibrations, there is one extra coefficient block, called the "operational block".

The program uses the coefficients in the operational block when processing the data from a beam measurement.

The operational block has the same form as the other coefficient blocks, but it's coefficients are updated differently, depending on which type of calibration is being performed.

How the program handles the multiple calibrations:



How the program handles the multiple calibrations:

External Baseline calibration coefficients go directly into the operational block. There is no better, more accurate calibration than an external calibration.

Internal Baseline calibration coefficients do not go into the operational block at all. These coefficients are saved to be used later and have no direct use for calibration.

Internal Recent calibration coefficients are treated differently.

- Offset coefficients go directly into the operational block.
- Gain coefficients are corrected for the 1% resistors before going into the operational block.
- VFDG timing values do not go into the operational block.

How to operate the calibration functions:

Trigger Source:
The control variable for the calibration functions is the "trigger source" ADO parameter. This variable is segmented into a bitwise control register.

CAL	CAL	CAL	CAL	CAL	CAL	CAL	CAL	CAL	OPER	OPER
BASELINE	WOOT	FLASH	X1	X10	OFFSET	CURVE	PEAK	INTERNAL	PROFILE	FIXEDTRIGGER
A 0x400	9 0x200	8 0x100	7 0x80	6 0x40	5 0x20	4 0x10	3 0x08	2 0x04	1 0x02	0 0x01

Trigger:
The calibration sequence begins upon receipt of the BPM turn-by-turn trigger over the beam sync clock. All other triggers and configuration changes are locked out until the calibration sequence is done.

Conditions to write to flash:

Calibration Tolerance:
There are hard-coded tolerance values that the program enforces on the coefficients determined from the calibration sequence. If the measurements are out of tolerance, the program will not write the coefficients to flash, unless we have chosen to override this safety measure.

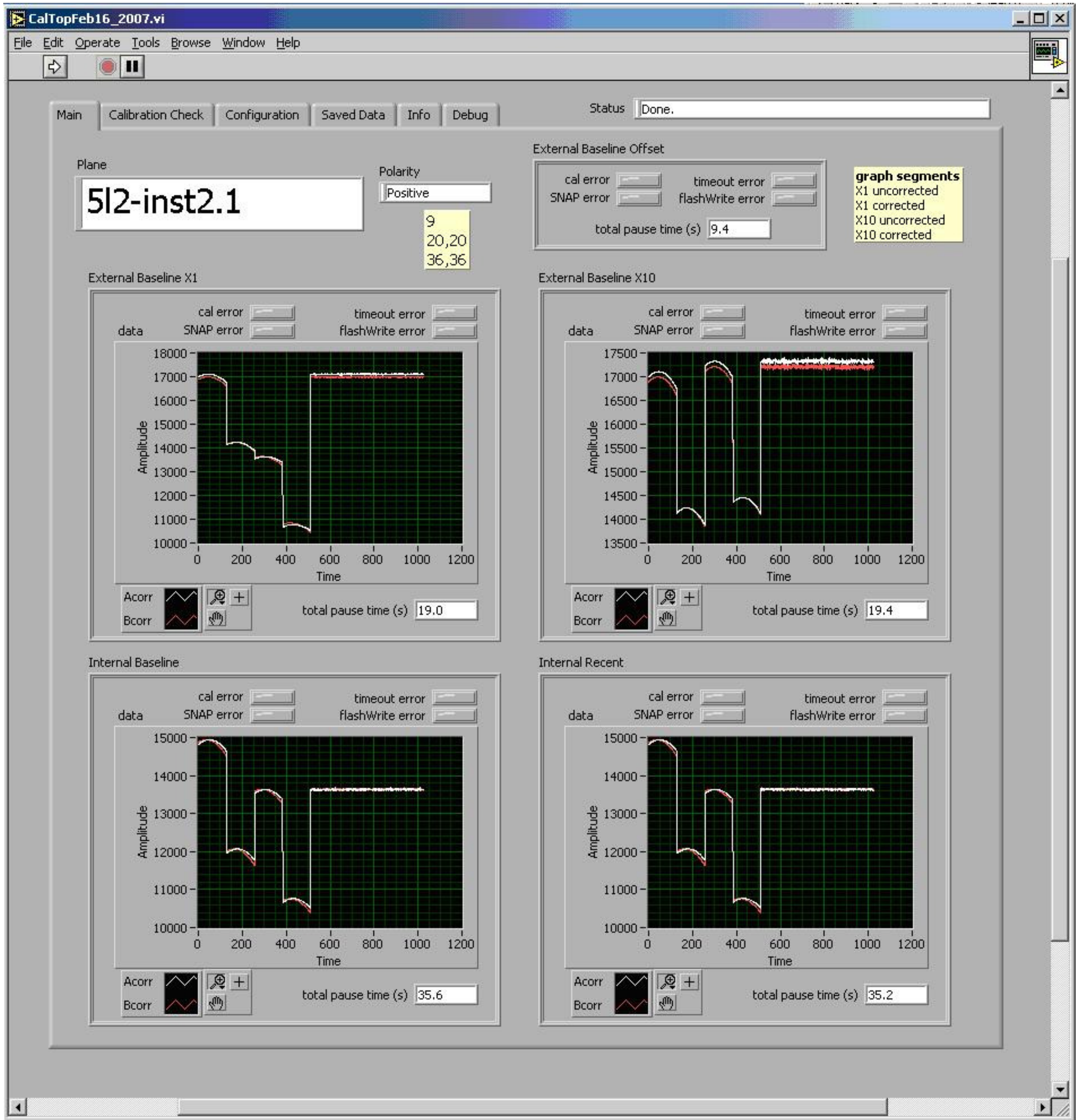
Calibration Key:
A layer of protection was added to avoid accidental, inadvertent, and unintentionally repetitive calibrations. This protection is called the “calibration key” and is an ADO parameter that must be set correctly in order for the program to write the new coefficients to the flash. The calibration will still be performed if the calibration key is not set properly, but no flash write will occur.

$$0 < (\text{RTDL\_time} - \text{trigger\_source} - \text{calibration\_key}) < 120$$

Calibration Data Returned by the IFE:

Data is returned to the ADO via the TBT buffer. This is a 4x1024 word buffer that has the following layout:

Pos	Trig Source	Atten 0dB	Flash Write?	Current x1 Coefficients	Operational x1 Coefficients
stvalid	Error Byte	Atten 20dB	Flash Write?	Current x10 Coefficients	Operational x10 Coefficients
ACorr	x1 curve A uncorrected	x1 curve A corrected	x10 curve A uncorrected	x10 curve A corrected	
BCorr	x1 curve B uncorrected	x1 curve B corrected	x10 curve B uncorrected	x10 curve B corrected	


CalTopFeb16_2007.vi
File Edit Operate Tools Browse Window Help
Main
Calibration Check
Configuration
Saved Data
Info
Debug
Status
Done.
Plane
5l2-inst2.1
Polarity
Positive
9
20,20
36,36
External Baseline Offset
cal error
SNAP error
timeout error
flashWrite error
total pause time (s) 9.4
graph segments
X1 uncorrected
X1 corrected
X10 uncorrected
X10 corrected
External Baseline X1
data
Amplitude
Time
Acorr
Bcorr
total pause time (s) 19.0
External Baseline X10
total pause time (s) 19.4
Internal Baseline
total pause time (s) 35.6
Internal Recent
total pause time (s) 35.2

How we operate the calibration with the VI:

- External Baseline (offset);(x1,x10)
- External Baseline (curve, peak);(x1)
- External Baseline (curve, peak);(x10)
- Internal Baseline (offset, curve, peak);(x1,x10)
- Internal Recent (offset, curve, peak);(x1,x10)
- Calibration Check x1
- Calibration Check x10